Variance in silica body anatomy of switchgrass (*Panicum virgatum*) across ecotypes and environment

Jardon M. Wargo[1], Raiza Castillo-Argaez[1], Claudia Garnica-Díaz[1], Jason Bonnette[2], Thomas E. Juenger[2], Grace P. John[1]

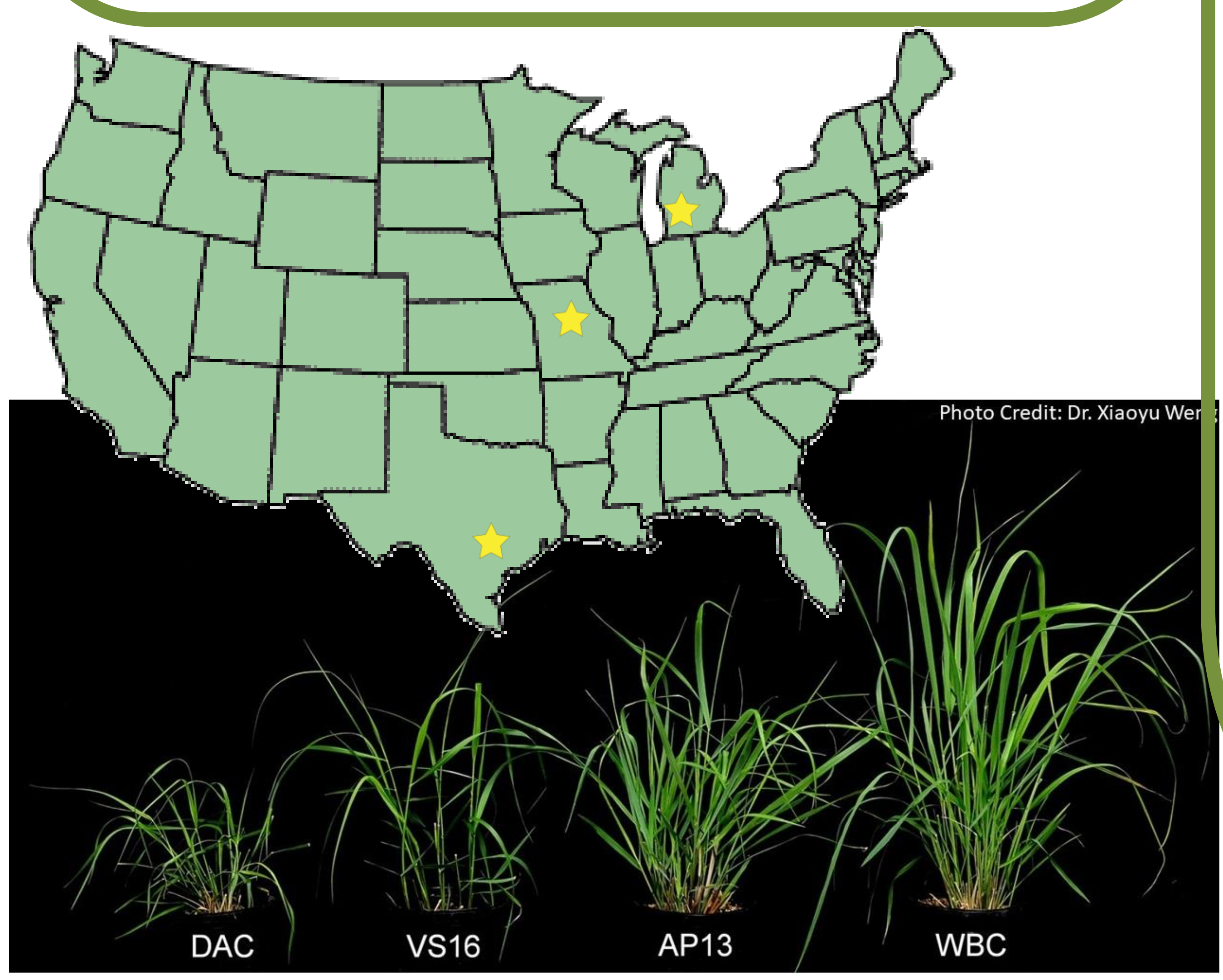
University of Florida[1], University of Texas at Austin[2]

Introduction

Switchgrass (*Panicum virgatum*) is a perennial grass and a potential biofuel candidate. Due to its wide growth range, switchgrass has developed a variety of ecotypes, which are genetically distinct populations adapted to their environment. Recently, breeding efforts have shifted towards exploiting natural phenotypes of upland and lowland ecotypes. Silica bodies in switchgrass leaves are a pertinent phenotype that can increase lifespan and improve stress tolerance; however, it negatively affects biofuel production, as the slag produced from silica during combustion decreases yield. Our goal is to determine the anatomical variation of silica bodies across upland and lowland ecotypes as well as any notable tradeoffs.

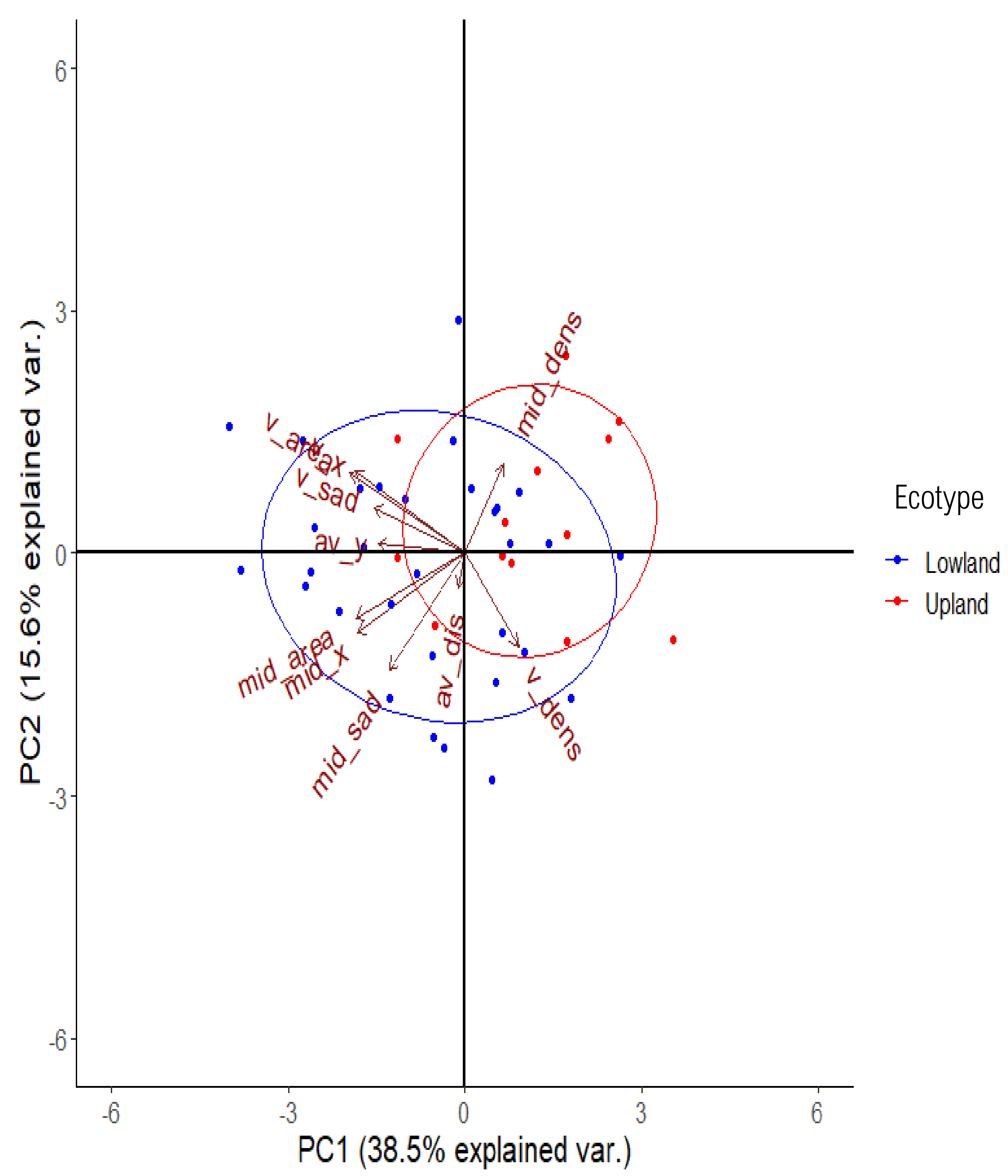
Methods

We conducted a reciprocal transplant experiment using common gardens across a latitudinal gradient: KBSM northmost in Michigan, CLMB in Missouri, and PKLE in Texas. Two genomes were selected for each ecotype, DAC and VS16 as uplands, North Dakota and Nebraska cultivars respectively, and AP13 and WBC as lowlands, Texas cultivars. To measure silica anatomy, we cleared the leaves and added immersion oil. Measurements were taken of the y-axis, x-axes, saddle width, perimeter, area, distance between bodies, and density. These measurements were taken for silica in the midrib as well as in the longitudinal vein.

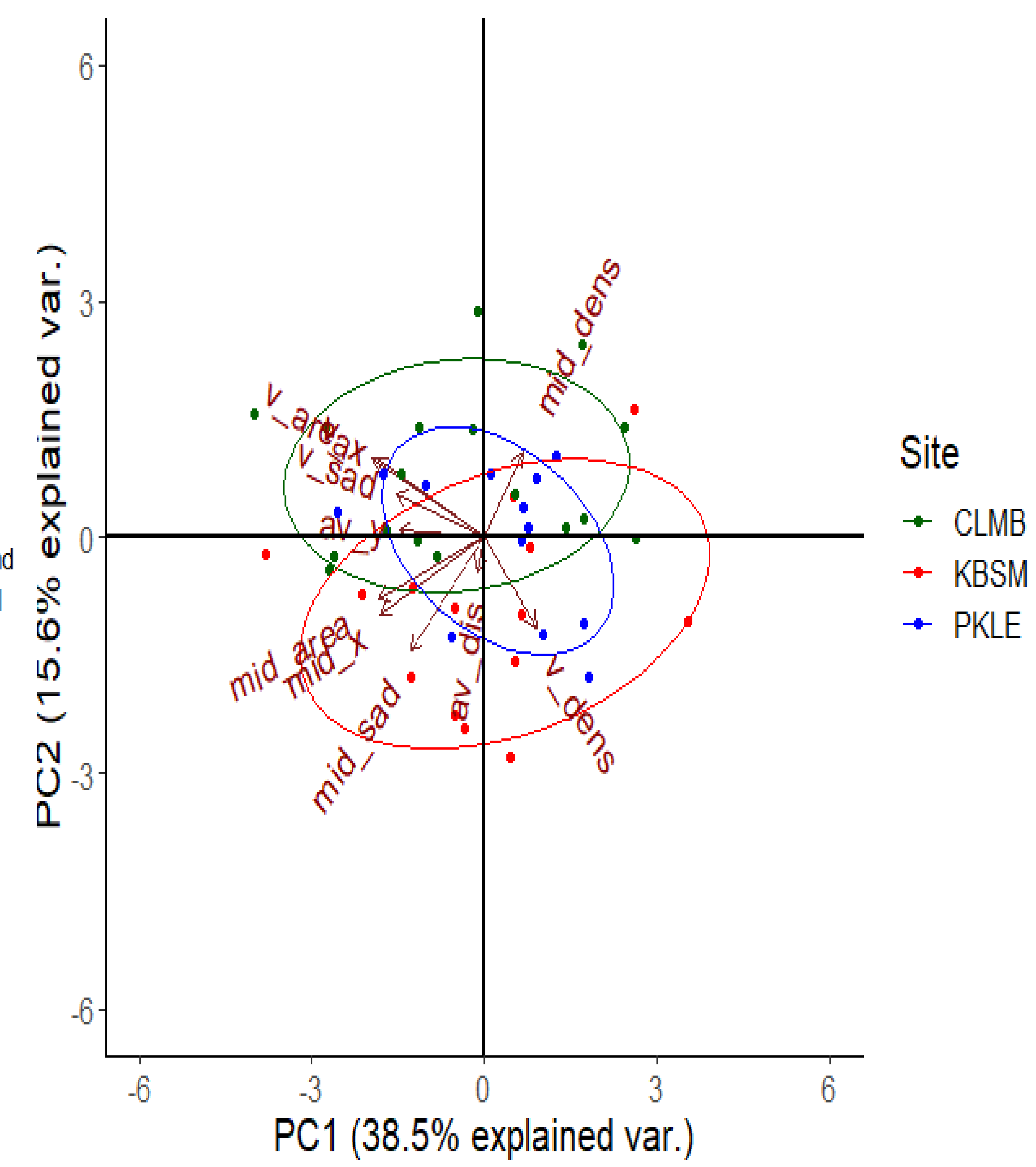


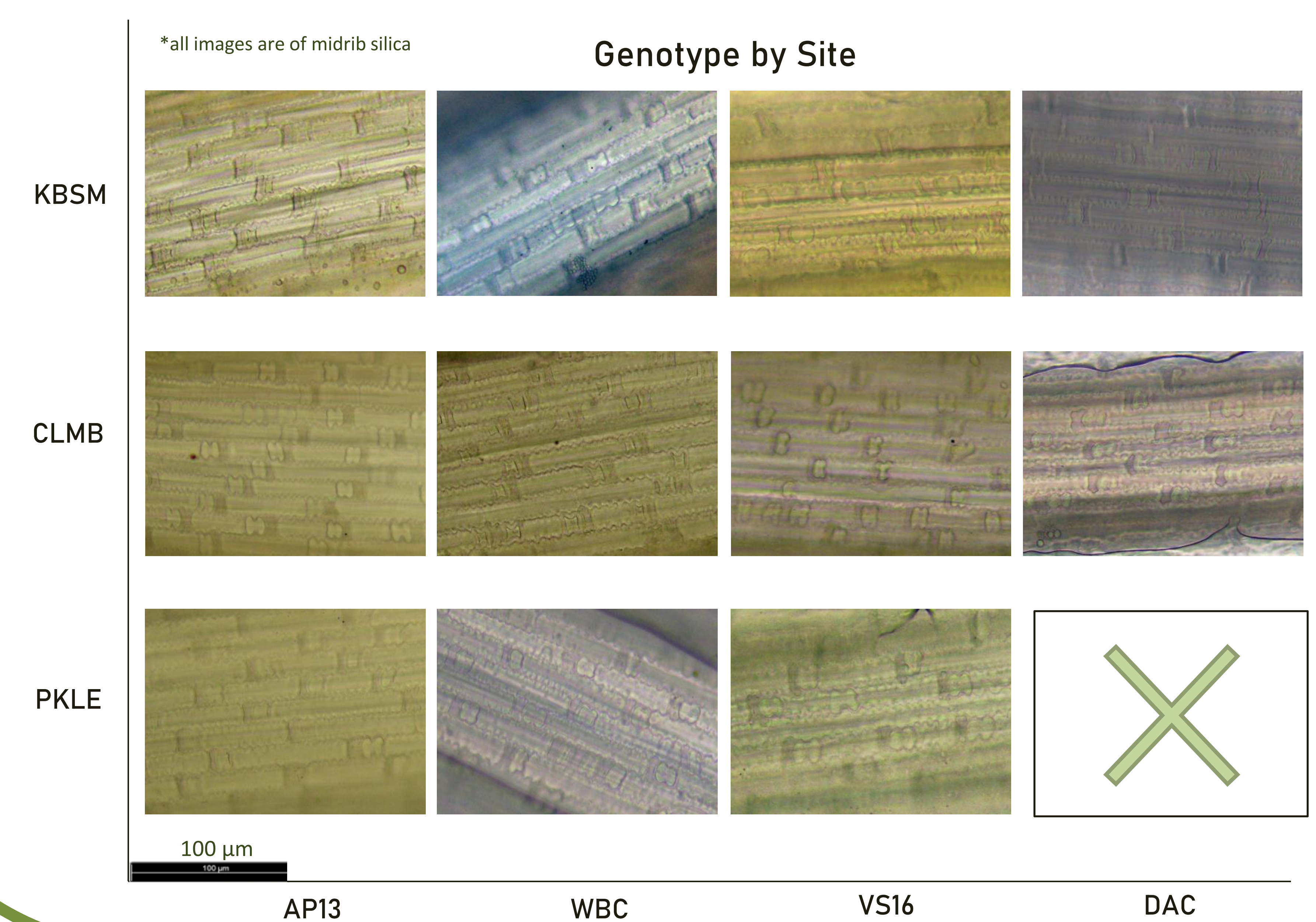
Results

PCA of Silica Anatomy by Ecotype (PC1 vs. PC2)



PCA of Silica Anatomy by Site (PC1 vs PC2)





Discussion

Principal component analyses (PCAs) were computed for silica anatomy by ecotype and by site. From the biplots, we can conclude that the x-axis, PC1, shows the size-density tradeoff, shown by density and area variables opposite one another across the y-axis. Similarly, the y-axis, PC2, describes the variation between vein and midrib silica anatomy. ANOVA tests run for PC1 and PC2 scores of both biplots found that PC1 was significantly variable with respect to ecotype ($p < 0.05$). Additionally, PC2 of the varied by ecotype by site ($p < 0.01$), suggesting a site effect on relative investment in midrib vs. vein silica.

Conclusion

From this research, we can conclude silica anatomy varies significantly by ecotype with a prominent size-density tradeoff. Additionally, we can conclude that silica size is a stronger trait than density. This is expected, as silica amount relates to longer lifespan, both of which are observed in lowland ecotypes. Site was not found to be a significant driver of anatomical variance on PC1, as the ellipses occupy the same trait space. However, on PC2, site has a significant effect. This difference in midrib and vein investment must have an environmental factor causing variation.

Future

We plan to analyze silicon concentration in the leaves and soil. We will do genetic mapping for these lines to determine genome by environment interactions, and we plan to identify genes that correlate to silica anatomy and concentration. Additionally, including climate data would be beneficial in understanding the mechanisms which drive differences between ecotypes.

References

Lowry et al. QTL × environment interactions underlie adaptive divergence in switchgrass across a large latitudinal gradient. *PNAS* June 2019, 116 (26) 12933-12941.